

Exhaust System Experiments at NASA's AeroAcoustic Propulsion Lab



- **Synopsis:** This presentation gives an overview of the planned testing in the AeroAcoustic Propulsion Lab (AAPL) in the coming 15 months. It was stressed in the presentation that these are plans that are subject to change due to changes in funding and/or programmatic direction. The first chart shows a simplified schedule of test entries with funding sponsor and dates for each. In subsequent charts are pages devoted to the Objectives and Issues with each test entry, along with a graphic intended to represent the test activity. The chart for each test entry also indicates sponsorship of the activity, and a contact person.



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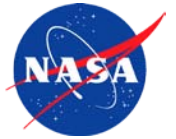
Presented to Acoustics Technical Working Group

James Bridges

21-22 April 2011

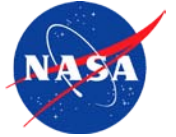
Cleveland, OH

AeroAcoustic Propulsion Lab Schedule



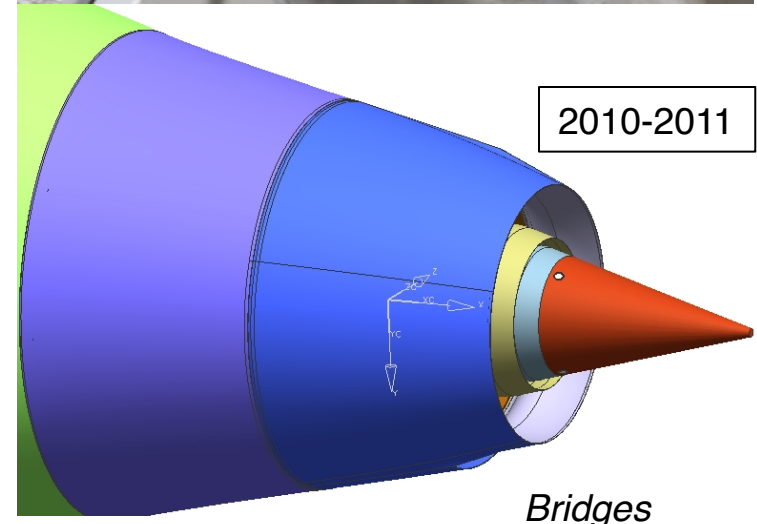
- Includes activities from Supersonics and Subsonic Fixed Wing Projects
- Tests in FY12 are tentative pending funding

Test	Fund	FY11		FY12			
		Q3	Q4	Q1	Q2	Q3	Q4
N+2 System Validation	SUP						
3Stream Base	SUP						
PAJE	SUP						
HFXF 2	SFW						
JSIT 2	SFW						
TwinRect	SUP						
ERN2	SUP						



N+2 System Validation Nozzle Tests

- Three-Stream Mixer-Ejector
 - Lockheed/RR-Liberty Works
 - Test begun 21 April at NATR
 - Current empirical codes predict success
 - RANS design of ejector crucial
 - RANS acoustic code prediction coming
- Inverted Velocity Profile w/Fluid Shield
 - Lockheed/GE Global
 - Test hardware in fab; test in May at NATR
 - Current empirical jet noise codes outside range of validity
 - RANS acoustic code prediction coming
 - LES underway at GE

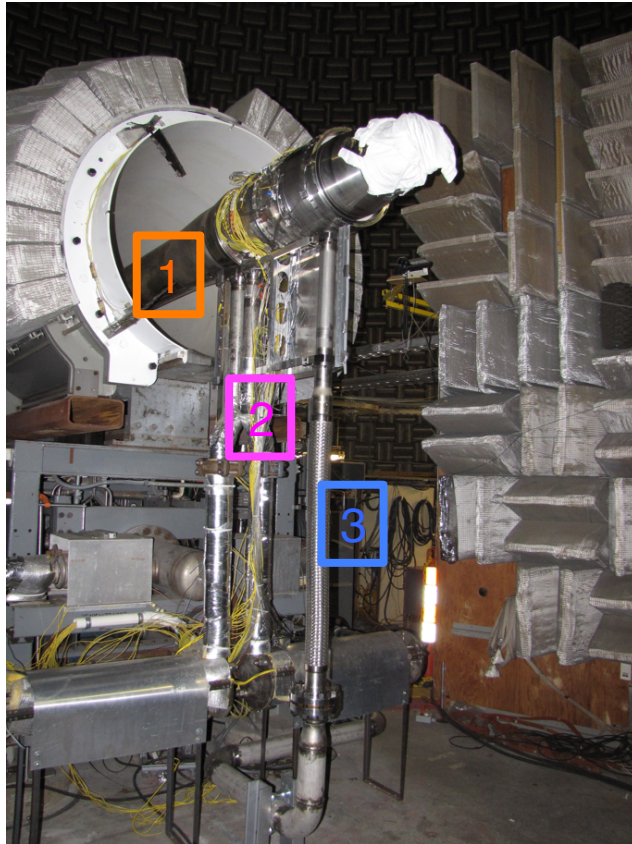


GE IVP concept

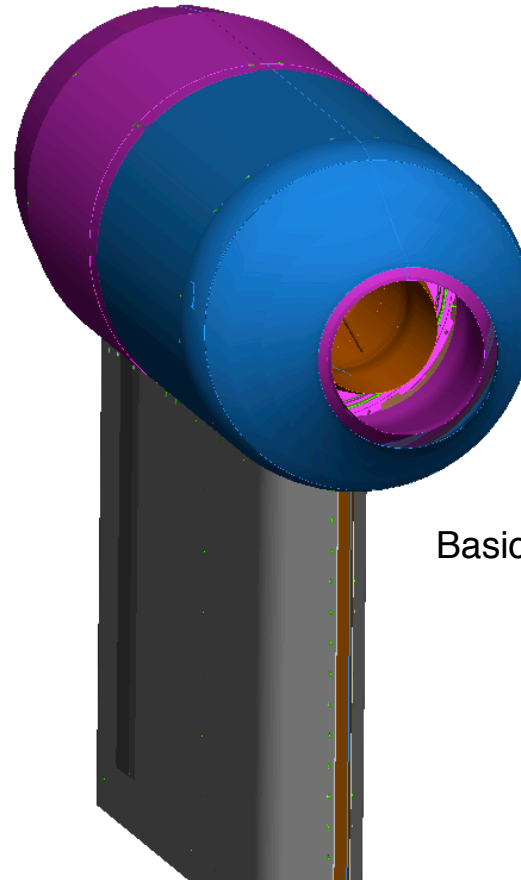


Three-Stream Jet Noise Database

- Objectives: Provide database of far-field jet noise from simple three-stream jet flows; develop semi-empirical jet noise prediction module and validate RANS-based acoustic codes for axisymmetric 3-stream jets.
- Issues: Limited range of area ratios/ mass flow ratios with existing hardware.



Three-stream jet rig in APL/NATR



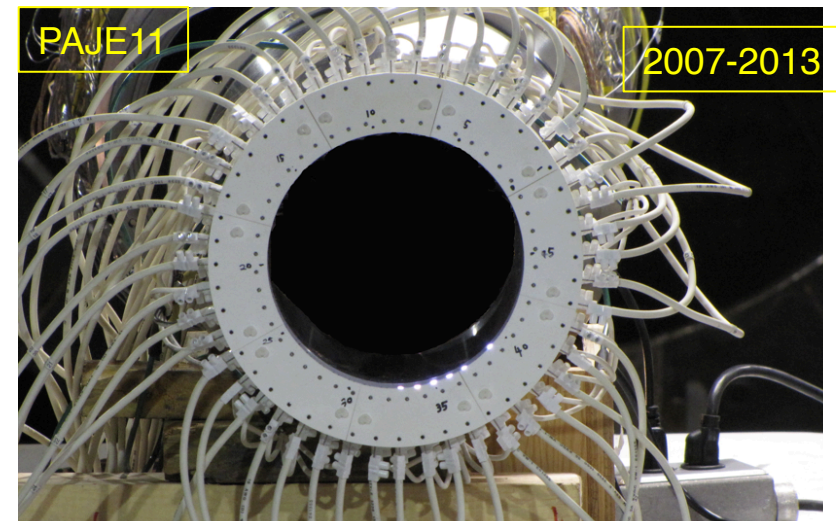
Basic Three-stream model

Henderson, Bridges



PAJE11 (*Plasma Arc Jet Excitation*)

- Jet Instability Manipulation for Noise Reduction
 - High-energy plasma actuators at nozzle lip
 - Azimuthal modes/ frequencies excited
 - Test of scaleup underway on NATR
 - 8 actuators on 1" jet (OSU) → 48 actuators on 6.5" jet (NATR)
 - Recent tests worked out issues with EMI, installation in NATR
 - End-to-end test inconclusive; diagnostics required



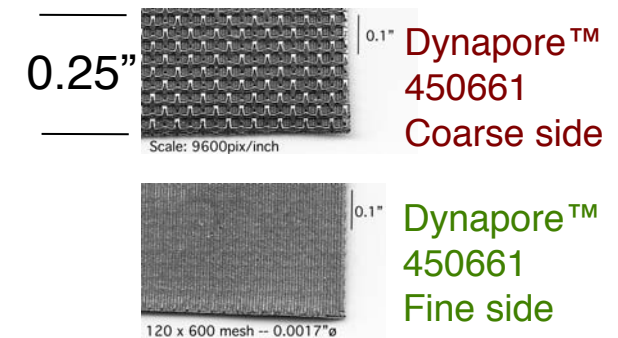
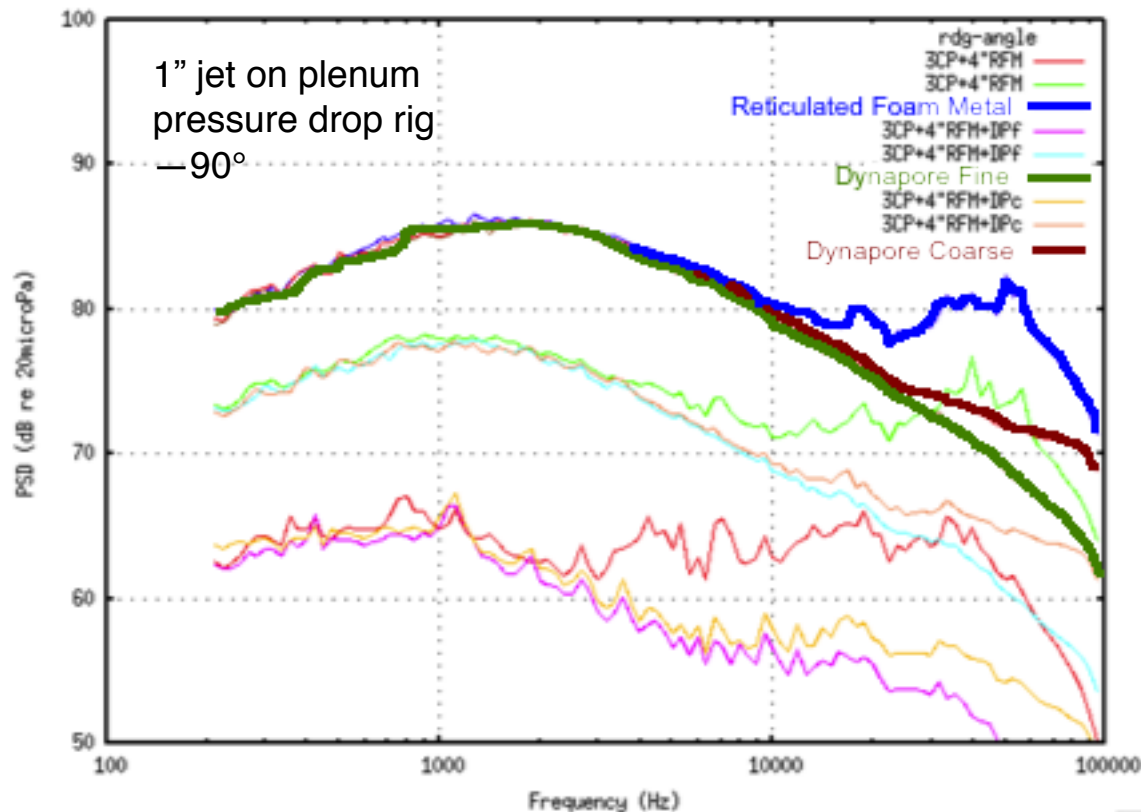
Actuators operating during PAJE11

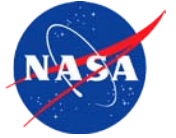
Brown



HFXF II (High-Flow Cross-Facility Test)

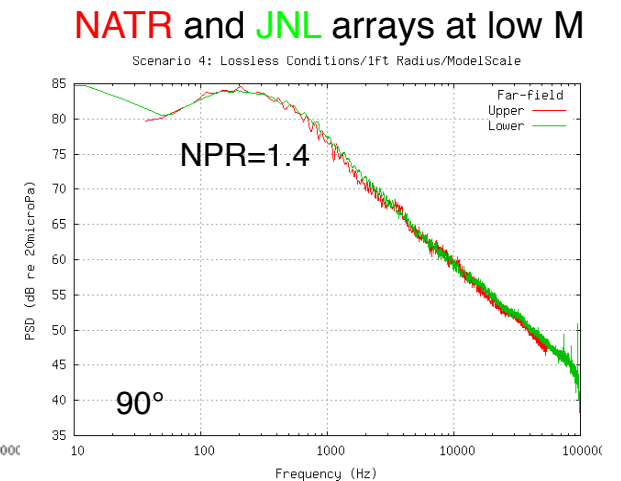
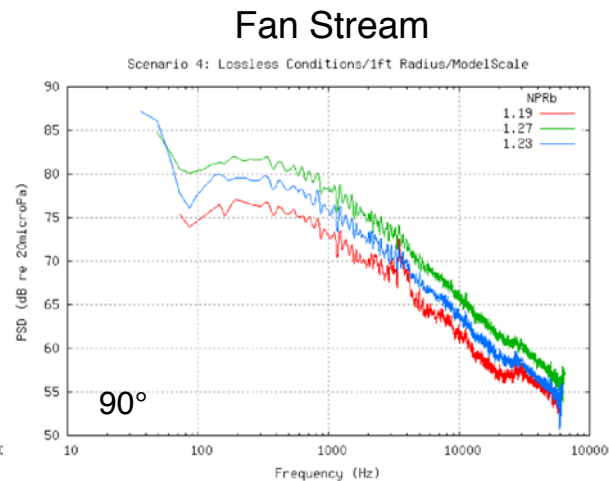
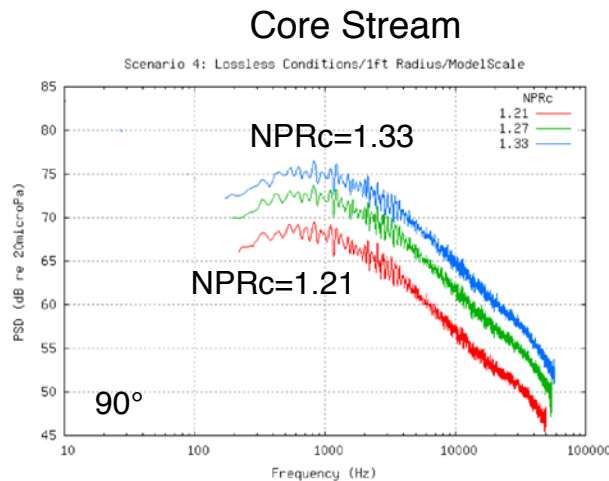
- Objective: Show cross-facility validation of same hardware in two jet rigs across cycle regime. Acquire ultra-high BPR jet noise with integration effects.
- Issue: NATR has had internal noise from flow conditioning; JNL has had high background levels. Neither could test configurations in SFW N+3 concepts.
- Recent improvements with Dutch weave screens for flow conditioning in NATR.





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- Issue: NATR has had internal noise from flow conditioning; JNL has had high background levels. Neither could test configurations in SFW N+3 concepts.
- Recent improvements with Dutch weave screens for flow conditioning in NATR.
- Measured approach cycle flows at BPR=8 nozzles in SBIR test in August 2010
- Clean, axisymmetric noise down to NPR=1.2



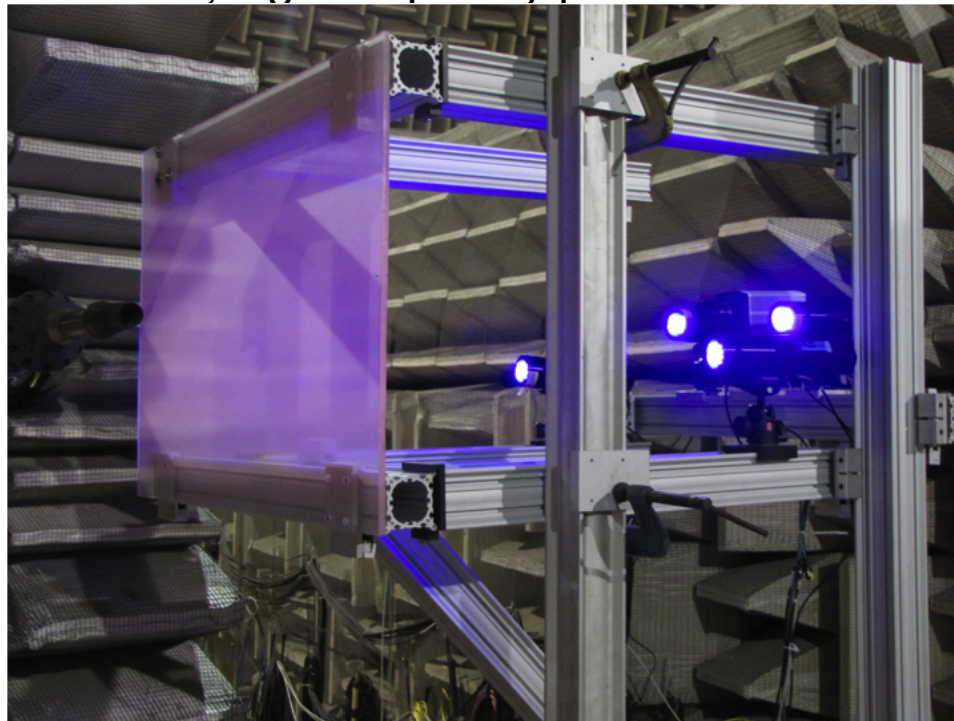
Rig Checks before ATA SBIR test in 2010.

Bridges, Brown

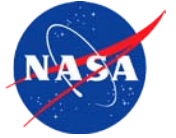


JSIT 2 (*Jet-Surface Interaction Test 2*)

- Objectives: Explore critical jet-surface configurations; hot jet data for reflecting configurations, phased array from more observer angles, obtain turbulent flow statistics and surface-pressure statistics; guide RANS-based modeling efforts and validate LES.
- Issues: Near-surface PIV; high frequency pressure-sensitive paint technology

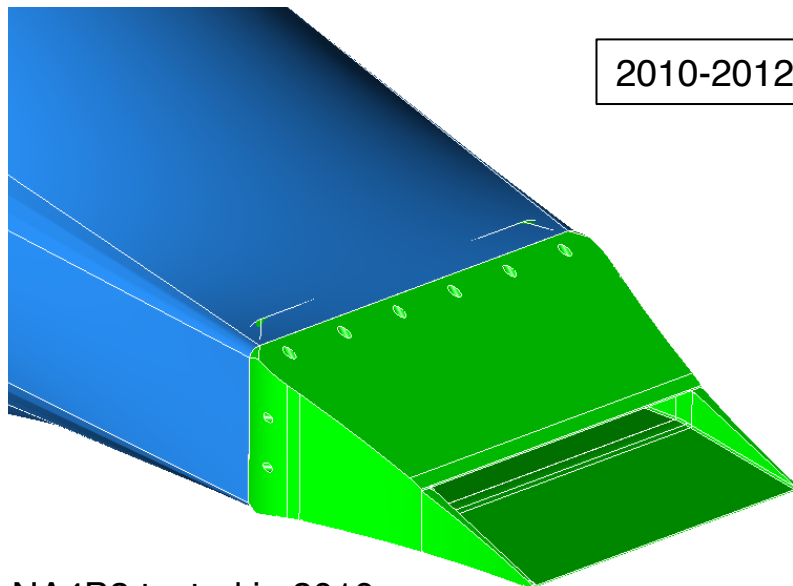


Pressure-sensitive paint during JSIT 1 *Brown, Podboy*



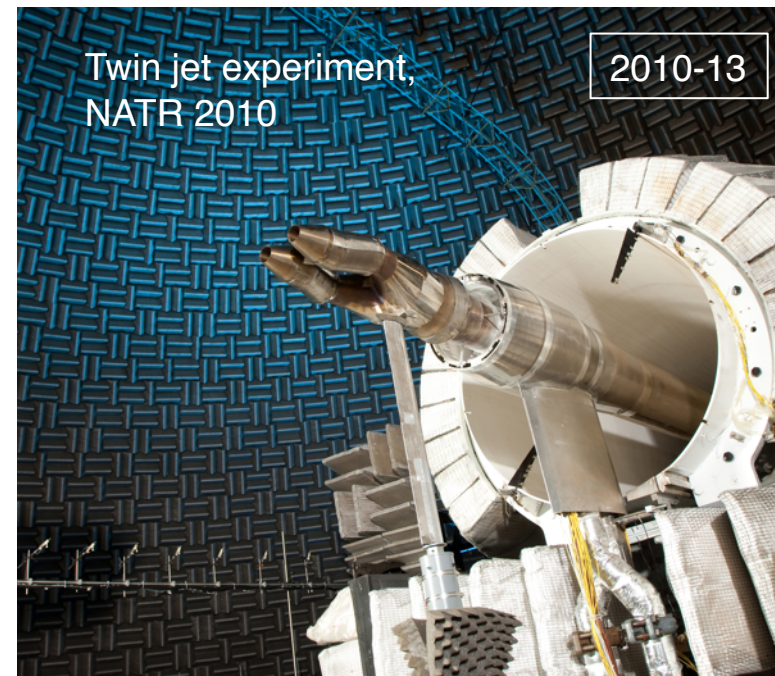
TwinRect (*Twin Rectangular Jets*)

- Objectives: Far-field acoustics: Acquire far-field noise for select ERN11 nozzles; explore how rectangular nozzle geometries modify twin-jet spectral directivities; PIV: Acquire turbulent velocity data for select TWN10 configurations, and ERN11, ERN12 nozzles; document flow for code validations.
- Issues: Downselect ERN11 nozzles; include JSIT?



2010-2012

NA4B2 tested in 2010

BridgesTwin jet experiment,
NATR 2010

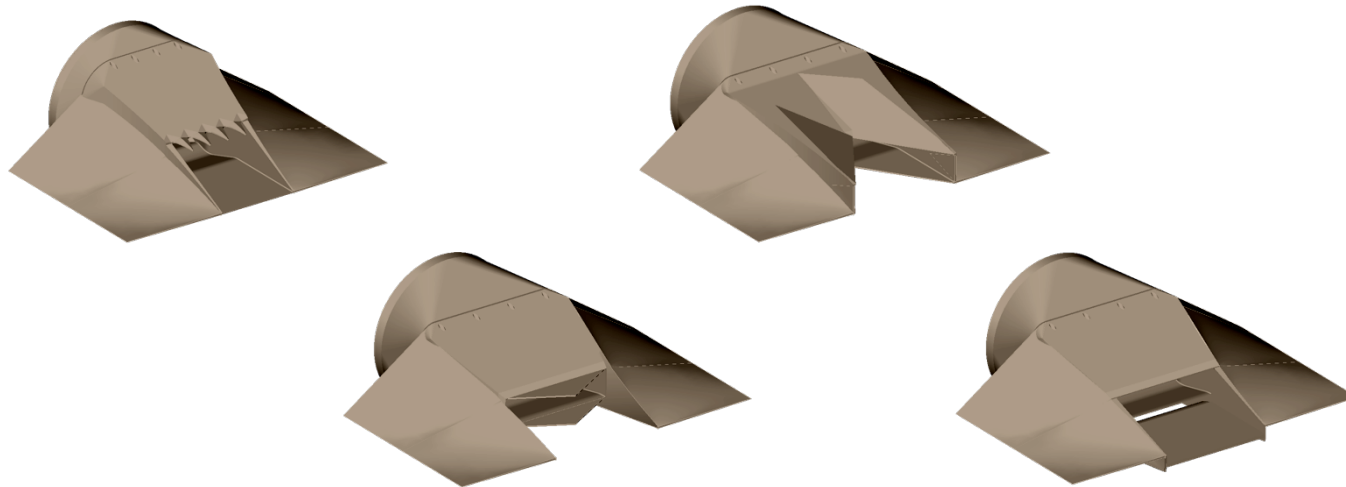
2010-13

Bozak, Henderson 9



ERN12 (*Extensible Rectangular Nozzle*)

- Objectives: Further explore spectral directivity of high aspect ratio nozzles based on ERN11 results, and CFD; acquire PIV of turbulent flow fields for code validations.
- Issues: Maturity of RANS-based acoustic codes, speed of CFD gridding



Potential ERN configurations

